Please replace the paragraph beginning at page 6, line 8 with the following paragraph:

This invention will be better understood after reading the following example embodiments given for information only and in no way restrictive, with reference to the attached drawings in which:

- Figure 1, described above, describes transmission variations in a conventional Bragg grating as a function of the wavelength,
- Figure 2 diagrammatically illustrates the interference diagram for two plane waves with no phase plate,
- Figure 3 diagrammatically illustrates the interference diagram for two plane waves in the presence of a phase plate,
- Figure 4 diagrammatically illustrates phase splitters placed in series,
- Figure 5 diagrammatically illustrates a curved phase plate,
- Figure 6 diagrammatically illustrates a phase splitter formed by a lens,
- Figure 7 diagrammatically illustrates a phase splitter with an index change,
- Figure 8 diagrammatically illustrates a phase splitter inclined with respect to an incident light beam,
- Figure 9 diagrammatically illustrates a support device for a phase plate that could be used in the invention,
- Figure 10 diagrammatically illustrates an amplitude separation writing process for a phase skip Bragg grating according to the invention, for an assembly with transverse irradiation,
- Figure 11 diagrammatically illustrates a wave front separation writing process for a phase skip Bragg grating according to the invention, using the prism method,
- Figure 12 diagrammatically illustrates another wave front separation writing process for a phase skip Bragg grating according to the invention, using a Lloyd mirror,
- Figure 13 shows variations in the transmission of a phase skip Bragg grating as a function of the wavelength,
- Figure 14 diagrammatically illustrates a partial double reflection in a Bragg grating around a phase change due to a cavity.
- Figure 15 diagrammatically illustrates propagative and counter-propagative coupling in a phase skip Bragg grating,
- Figure 16 diagrammatically illustrates an example of an index modulation with linear envelope, and
- Figure 17 diagrammatically illustrates an example of an index modulation apodized by a Gaussian curve.

Please replace the paragraph beginning at page 8, line 2 with the following paragraph:

64 According to this invention, interference is generated with one or a plurality of phase shifts by means of one or a plurality of optical phase shifting elements or phase plate.

Please replace the paragraph beginning at page 8, line 6 with the following paragraph:

65 The first step (Figure 2) is the simple case of two plane light waves O_1 and O_2, output from the same light beam and with no phase plate. The electrical fields for these two waves are denoted $\vec{E}_1 and \vec{E}_2$, the corresponding wave planes are denoted P_1 and P_2 and the corresponding wave vectors are denoted $\vec{k}_1 and \vec{k}_2$. The modulus of $\vec{k}_1 and \vec{k}_2$ is denoted k, and the modulus of $\vec{E}_1 and \vec{E}_2$ is denoted ξ_o. The intensity I (z) resulting from the interference of these two waves on the Oz axis in Figure 2 is therefore in the form:

Please replace the paragraph beginning at page 9, line 3 with the following

paragraph:

66 The zones I and II corresponding to two parallel sub-beams formed by the wave O_2 after it has passed through the plate 2, which is thicker in the part facing area II than in the part facing area I. The intensity I (z) then becomes:

Please replace the paragraph beginning at page 9, line 15 with the following

paragraph:

67 On Oz, the phase change abscissa is determined by the relative position of the splitter 2 with respect to beam O2. Therefore, this abscissa z_t can be modified very easily by the plate translating along a y axis parallel to this plate. It can be seen that the interference area is delimited by the abscissas O and z_f on the Oz axis.

Please replace the paragraph beginning at page 9, line 22 with the following

paragraph:

68 The value $\Delta\Phi$ is determined by the difference in optical path in the plate between areas I and II. This plate can be made such that $\Delta\Phi = \pi$. Furthermore, this value can be modified very simply by rotating the plate at an angle Θ to incline this splitter with respect to beam O_2.

Please replace the paragraph beginning at page 9, line 28 with the following paragraph:

G9

According to the invention, two waves with multiple phase changes can also be made to interfere; in the same way as a phase plate comprising a step induces a phase shift in the interference pattern as shown in Figure 3, a series of plates 4, 6, 8 placed in sequence can be placed in one O3 of the two interfering beams (for example ultraviolet beams) (Figure 4). The result is then an interference pattern with a series of phase changes corresponding to steps 10, 12, 14 in splitters 4, 6, 8 respectively.

Please replace the paragraph beginning at page 10, line 2 with the following paragraph:

G10

Another solution is to combine this series of plates into a single plate that induces a series of phase shifts by multiple changes in the optical path (stepped splitter).

Please replace the paragraph beginning at page 10, line 12 with the following paragraph:

G11

We will now explain the production of a phase plate. The material from which is plate is made must be transparent to the wavelength(s) that will be used to write the Bragg grating by photosensitivity in a light guide.

Please replace the paragraph beginning at page 10, line 17 with the following paragraph:

G12

In the following, the production of a single phase change plate is described, but plates with several phase changes could be made in a similar manner.

Please replace the paragraph beginning at page 10, line 21 with the following paragraph:

G13

The plate, or the element creating the optical phase shift that is the easiest to make and the most practical to use has a parallelepiped shape. When this type of plate is inserted in a beam, the input wave front also appears at the output, but there are one or several additional phase shifts due to at least two different optical paths (Figure 3).

Please replace the paragraph beginning at page 10, line 28 with the following paragraph:

For some applications of the invention, it may be necessary to use a non-parallelepiped shaped plate in order to adapt the configuration of this plate to the wave front of the beam for which the phase is to be shifted. For example, it may be necessary to make a phase change without changing the propagation characteristics of a non-parallel beam in which the plate is inserted; for example (Figure 5) a plate 9 delimited by two coaxial cylindrical faces 11 and 13 can be made; due to the optical path transition symbolized by line 15, a plate of this type placed in a beam that converges o the axis common to the faces, induces a phase shift on the beam as shown in the example in Figure 3.

Please replace the paragraph beginning at page 11, line 11 with the following paragraph:

A phase change may also be necessary with a change in the beam propagation characteristics. For example, this could be done using a lens that could be considered as a non-parallelepiped shaped plate. The phase change is then inserted using the same principle as above. A cylindrical lens 16 can be seen in the example in Figure 6, that focuses a beam while applying a phase skip to it due to the transition of the optical path symbolized by line 17.

Please replace the paragraph beginning at page 11, line 20 with the following paragraph:

The phase skip I the plate can be obtained by changing its thickness. This can be done by etching one or several parts of the plate or by depositing one or several layers on one or several parts of the splitter. For example, considering a plate with two areas with thicknesses e_1 and e_2 respectively, the wave front is deformed after passing through the plate due to the phase shift $\Delta\Phi = (2\pi / \lambda)\ (n-1)\ (e_2 - e_1)$ where n is the index of the material from which the plate is made and λ is the wavelength of the beam that passes through it.

Please replace the paragraph beginning at page 12, line 1 with the following paragraph:

§17 Thus, a plate with a thickness e2 can be used that is inserted in a certain beam thickness perpendicular to the wave planes of the beam (hence $e_1 = 0$).

Please replace the paragraph beginning at page 12, line 5 with the following paragraph:

§18 The wave propagation index in one or several parts of the plate can also be modified to induce one or several optical path changes and therefore one or several phase skips. For example, consider a plate with thickness e and index n. If the index becomes n' for a thickness e' as shown in Figure 7, the result will be e' (n'-n) = (2k +1) λ / 2 (where k is an integer number). However, when the plate is inclined (in order to adjust the phase shift), the two beams do not "see" the same index and therefore will be deviated differently. Therefore, a phase plate with an index change at normal incidence should be used.

Please replace the paragraph beginning at page 12, line 17 with the following paragraph:

§19 In the case of a plate with a thickness change, different phase shift values can be obtained by changing the inclination angle Θ of the plate with respect to the beam without inducing any angular separation. The inclination or rotation may be made about an axis A (Figure 8) parallel to the edges of the step that delimits the phase skip, or about an axis B perpendicular to the edges of the step and in a plane parallel to the two faces of the splitter.

Please replace the paragraph beginning at page 13, line 10 with the following paragraph:

§20 Figure 9 shows a device 18 supporting a phase plate 20 used to insert the phase plate in a beam. This device comprises adjustment means that provide it with various degrees of freedom. The stacking order of these adjustment means is arbitrary. For the example shown, Figure 9 shows six adjustment means 19-1 to 19-6 corresponding to six degrees of freedom $\alpha, \beta, \theta, y, z$ and x (<<y>>, <<z>> being the translations along the y and z axes perpendicular to each other; <<x>> being the translation along the x axis perpendicular to each of the y and z axes; and $<<\alpha>>, <<\beta>>$ *and* $<<\theta>>$ being the rotations about axes parallel to y, z and x respectively). However, the support device may have more or less degrees of freedom depending on the configuration of the splitter and the wave front of the incident beam, and depending on the interferometric setup in which it is to be inserted (for example z is not essential).

Please replace the paragraph beginning at page 14, line 1 with the following paragraph:

For example, a parallelepiped-shaped plate can be adjusted based on five degrees of freedom:

- α and β to keep the material change edges 22 vertical, that can also be achieved by construction,
- x to position the plate in the beam,
- θ to adjust the phase shift value,
- y to adjust the position of the phase skip in the Bragg grating.

Please replace the paragraph beginning at page 14, line 17 with the following paragraph:

In the following examples, different configurations of interference setups are shown with the insertion of a phase plate device in order to introduce a single phase change in a Bragg grating. Two writing configurations of a Bragg grating are considered. The first is an amplitude separation configuration in which the two beams are separated for energy but keep the same shape. The second is a wave front separation configuration.

Please replace the paragraph beginning at page 15, line 1 with the following paragraph:

The second setup corresponds to a setup with three mirrors (see document (1)). In both cases, a separating plate 24 (Figure 10) divides a light beam 26 into two identical beams 28 and 30. An interferometric system with two or three mirrors (two mirrors 32 and 34 in the example in Figure 10) superposes these two beams 28 and 30 that for a given angle ψ, at the fiber 36. The interferences thus created write the grating in the fiber by cylindrical focusing lenses 38 and 40. The phase plate 42 needs to be placed in one of the two interfering beams.

Please replace the paragraph beginning at page 15, line 12 with the following paragraph:

In general, the disadvantage of the amplitude separation setup is due to the fact that the phase splitter has to be adjusted each time that the Bragg wavelength is modified since the orientation of the insolation beam is modified. In order to overcome this disadvantage, the plate support device (not shown) must be controlled along degrees of freedom y and θ (see above) by a program that takes account of the setup beam movements necessary for adjustment of the Bragg wavelength.

Please replace the paragraph beginning at page 15, line 22 with the following paragraph:

We will now consider wave front separation configurations, and firstly an interferometric setup with a prism. Note that the method of separating the wave front has the advantage that the phase plate can be placed immediately after the beam expansion system before the wave front separation. An important advantage of this configuration is that the phase shift can be adjusted by rotating the splitter independently of the Bragg wavelength adjustment that is obtained by rotating the interferometric system.

Please replace the paragraph beginning at page 16, line 1 with the following paragraph:

The prism writing method (see document (8)) is diagrammatically illustrated in Figure 11 in which an extended beam 44 is "folded on itself" by reflection on a face of the prism 46. In Figure 11, the reference 48 shows a cylindrical lens. It can be seen that the determination of the Bragg wavelength fixed by the inclination of the two interfering beams, can be adjusted by rotating the prism, against which the fiber 36 is placed. If this rotation is made about an axis perpendicular to the plane of the Figure and passing through the phase skip projected in the optical fiber, then the phase plate 42 placed on the trajectory of the beam 44 in front of lens 48, does not need to be adjusted for the different prism positions.

Please replace the paragraph beginning at page 17, line 30 with the following paragraph:

The distribution of intensity in the plane of the CCD camera is characteristic of the envelope of the intensity distribution of the two half parts of the beam on the focusing line at the Lloyd mirror. Provided that the Fresnel diffraction effect between the grating and the camera can be corrected, this distribution can be used to determine the envelope of the beam intensity generating the Bragg grating. This setup property is used to adjust the position in the grating of the phase skip(s) (using the y degree of freedom), with optimum control due to the diffraction pattern generated by edge effects related to each thickness change in the phase plate. When this adjustment has been made, the laser beam is focused in the optical fiber and writing the required Bragg grating can begin.

Please replace the paragraph beginning at page 25, line 3 with the following paragraph:

5. Production cost: the cost of the apparatus is not very high since it is not expensive to manufacture a phase plate by deposition, and it is relatively easy to install it on a moving plate. Since the apparatus is also capable of writing all possible wavelengths, it can also be considered as being very cost effective. It is also economically attractive since it ca be used to make other components.

Please replace the paragraph beginning at page 25, line 22 with the following paragraph:

If several phase plates are placed in the path of the beam, Bragg grating with multiple phase skips can be written, the advantage of which has already been described (see document (13)).

Please replace the paragraph beginning at page 27, line 17 with the following paragraph:

The invention solves this problem in a very simple and inexpensive manner. The phase plate is placed in the beam using the device with several degrees of freedom. The position of the phase skip is outside the grating such that the phase in the grating is constant. The grating is then written in the same way as if there had been no plate. If the decision is made to erase the grating, then the device is ordered to translate the splitter to create a phase change of π over the entire grating. For example, for a Lloyd mirror grating, this is equivalent to placing the phase skip on the optical axis of the beam, to shift the two interfering parts out of phase by π. This then prolongs writing until the grating spectrum disappears.

Please replace the paragraph beginning at page 34, line 1 with the following paragraph:

The first two test gratings can be erased using the method described above. We can now write the Fabry-Perot cavity grating. The phase skip is placed at a distance l_1 from the edge of the grating using an apparatus conform with the invention, a grating is written for a time t_1, and the plate is then moved by translation using its support device over a distance e, and writing is prolonged by a time t_2. The Fabry-Perot cavity Bragg grating is written.

Please replace the paragraph beginning at page 40, line 23 with the following paragraph:

E32

2. Ease of use: it is easy to produce the grating. All that is necessary is to measure the growth function of a grating at a given power, and then to invert the function A (z) to be produced. Each plate support device, with its control software installed on it, then manages displacement of the corresponding splitter.

Please replace the equation in the specification on page 21, line 5 with the following:

E33

$$\frac{dA^+}{dz} = j\Omega A^- e^{-j[2\Delta\beta.z+\phi(z)]}$$

Please replace the equation in the specification on page 22, line 2 with the following:

NE

$$C_2 = \Delta\beta\gamma\sinh(\gamma L)$$

Please replace the equation in the specification on page 22, line 8 with the following:

E34

$$T = \frac{\gamma^4}{\Delta\beta^2(\Delta\beta^2\cosh^2(\gamma L) + \gamma^2\sinh^2(\gamma L) - 2\Omega^2(\cosh(\gamma L)) + \Omega^4)}$$

Please replace the equation in the specification on page 31, line 3 with the following:

NE

$$\Delta n_0 / 2$$

NE

Please replace "z2" in the specification on page 31, line 12 with the following:

$$z_2$$

Please replace the equation in the specification on page 31, line 21 with the following:

E35

$$\Delta n(z) = \Delta n_1(z) + \Delta n_2(z) = \Delta n_{aver} - \Delta n_0.\cos\left(\frac{2\pi}{\Lambda}.z\right)$$

Please replace the equation in the specification on page 42, line 9 with the following:

$$z_n^2(t) = \frac{L}{2}\left[1 + \frac{2}{N}\cdot\sqrt{\ln\left(\frac{T}{T-2t}\right)}\right]$$

In the claims:

Please amend claims 13-24 as follows:

13. (Once Amended) A process for writing a Bragg grating in a transparent substrate, the Bragg grating forming a spectral filter with regard to a light wave that passes through it, the process comprising:

generating an interference pattern between two light beams with the same wavelength and coherent with each other but with angular offset; and

writing said interference pattern to the substrate, in the form of a modulation of the refraction index of the transparent substrate, with a phase plate having an adjustable position and orientation,

wherein said phase plate divides at least one of said light beams into at least two sub-beams, creates a phase shift between said at least two sub-beams, and generates a corresponding phase shift in the Bragg grating.

14. (Once Amended) The process according to claim 13, wherein said writing further comprises using an amplitude separation configuration.

15. (Once Amended) The process according to claim 13, wherein said writing further comprises using a wave front separation configuration.

F1
436 X
[illegible]

16. (Once Amended) The process according to claim 13, wherein the position of said phase shift or the value of said phase shift or the position and value of said phase shift in the light beam formed by said at least two sub-beams, is modified with time.

17. (Once Amended) An apparatus for writing a Bragg grating in a substrate, said apparatus comprising:

at least one phase plate capable of creating a phase shift between at least two sub-beams; and

means for adjusting the position of said phase plate said means for adjusting having at least two degrees of freedom, one being angular degree of freedom provided for adjustment of the value of the phase shift, and the other being a translation degree of freedom provided for adjustment of the position of the phase shift in the light beam formed by the two sub-beams.

18. (Once Amended) An apparatus according to claim 17 further comprising interferometric means with two or three mirrors for transferring the interference pattern according to an amplitude separation configuration, said interferometric means coupled to said means for adjusting.

19. (Once Amended) An apparatus according to claim 17 further comprising interferometric means with a prism for transferring the interference pattern according to a

wave front separation configuration, said interferometric means coupled to said means for adjusting.

20. (Once Amended) The process according to claim 13, wherein the phase shift between said at least two sub-beams is substantially equal to π.

21. (Once Amended) The process according to claim 13, further comprising:

writing said interference pattern in the substrate with a phase plate, wherein the substrate includes a pre-written identical Bragg grating, at the same position, with a phase change of over the entire length of the prewritten grating, to erase all or some of the pre-written grating in order to obtain a given reflection coefficient.

22. (Once Amended) The process according to claim 13 further comprising:

forming a Fabry-Perot cavity delimited by two Bragg gratings at different positions in space.

23. (Once Amended) The process according to claim 13 further comprising:

forming a Bragg grating with a determined index modulation envelopeby successively writing two Bragg gratings comprising parts in phase opposition, the time taken to overwrite one Bragg grating by the other being variable, the position of the phase shift being variable and the value of the phase shift being variable.

E34 F1 end

24. (Once Amended) The process according to claim 23, wherein the position of the phase shift is being displaced by a programmable movement.

Sub F1 E37

25. (New) The process according to claim 13, wherein said light guide is an optical fiber.

26. (New) The process according to claim 23, wherein the Bragg grading is an apodized Bragg grading.

27. (New) An apparatus according to claim 17 further comprising interferometric means with a Lloyd folded mirror for transferring the interference pattern according to a wave front separation configuration.